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A TREATISE

ON THE

ART OF FLYING,

BY MECHANICAL MEANS:

WITH

A FULL EXPLANATION OF THE NATURAL PRINCIPLES BY WHICH BIRDS ARE ENABLED TO FLY:

LIKEWISE

INSTRUCTIONS AND PLANS,

FOR MAKING A FLYING CAR WITH WINGS, IN WHICH A MAN MAY SIT, AND, BY WORKING A SMALL LEVER, CAUSE HIMSELF TO ASCEND AND SOAR THROUGH THE AIR.

ILLUSTRATED WITH PLATES.

BY THOMAS WALKER,
Portrait Painter, Hull.

NEW-YORK:

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THE American publisher of this Treatise h
been induced to reprint it, not from a belief in th
importance or practicability of becoming aerial
voyagers, but from an opinion, that the ingenuity
of argument, and the information it contains, are
worthy of notice; and that it may have a ten-
dency to inculcate humanity and tenderness to-
ward the inferior orders of Creation. Should it
be found to promote this effect, he will not con-
sider his labours lost.

JAN 1 1907

TO

THE RIGHT HON.

EARL STANHOPE.

MY LORD,

AS far as an obscure individual like my-
self can judge of exalted characters, I am induced,
in unison with public opinion, to hold a belief
that your lordship is possessed, in a very superior
degree, both of genius and a knowledge of the
sciences; as well as a known predilection for ev-
ery thing that is calculated to improve and ex-
tend the mechanic arts, or to meliorate the condi-
tion of mankind.

To acknowledge also that your lordship is
equally pre-eminent in the senate, is but paying a
tribute which is very justly due to your patriot-
ism, and the great exertions which you have made
in advocating the cause of humanity. Every
friend to his country must hold in grateful remem-
brance, the energetic and manly opposition which
your lordship evinced to prevent the commence-
ment of a war more undefined in its object, more
inefficient, and more direful and ruinous in its con-
sequences to our country, than any war it was
ever madly and unjustly plunged into.

My countrymen have now great cause also to remember, with indignation and deep regret, that, in return for your opposition to the origin of those baneful effects, which your lordship clearly foretold, and are now but too severely felt; in return for your wise counsels, and patriotic zeal, your lordship met with every coarse insult and contumely, which blind folly and malice could suggest. But your lordship has this inestimable consolation, that your life has been most honourably engaged; not with the savage arts of murder; not with the burning of towns, and the destruction of their unoffending and defenceless inhabitants; not with the filling of Europe with miserable widows and orphans; not with the ruin of manufactures and commerce, and the violation of the sacred constitutional rights and liberties of your countrymen; not with the low, base, and contemptible arts of any corrupt and venal faction; not with the arts of tyranny and oppression, or force and fraud; not with the machiavelian arts; but with the noble arts which are conducive to peace, civilization, and the convenience and happiness of mankind.

Had I invented a diabolical engine that would effectually have swept off from the earth a considerable portion of its unwary inhabitants, I should never have thought of addressing your lordship; I must have sought patronage from another quarter; but considering the subject of this work, I thought no one was more able than your lordship to form a just estimation of its merits;

I have, therefore, taken the liberty of dedicating it to you; flattering myself that the theory it contains, will be honoured with your lordship's approbation, which will greatly contribute to the pleasure of, my lord,

Your lordship's humble Servant,

THOMAS WALKER.

Hull, Feb. 1810.

PREFACE.

I am laying before the public a treatise upon a subject, perhaps, as extraordinary in its nature as any thing that has lately come before them; and after a candid perusal, should it meet with approbation from the friends to arts and sciences, my utmost pride will be gratified. The flight of birds, although so common and familiar to our sight, is certainly as great a phenomenon as any in the creation; and artificial flying, when accomplished, may be considered as one of the greatest wonders of the mechanic arts; which I firmly believe attainable upon the plan I have suggested.

In this little work, I have shewn that birds' wings do not increase their expansion in exact ratio with the increased specific gravity of their bodies; I have given a demonstration of the cause of the projectile motion of birds, the discovery of a true knowledge of which has bid defiance to philosophers in all ages; which, with other discoveries, I trust will prove that I have given consistency to what henceforth may be denominated the science of flying, and which may alone be deemed of considerable importance to science, had nothing more than that been brought forward; but as I have gone much further, and have advanced arguments, and given plans to render the art of flying practicable, the importance of this

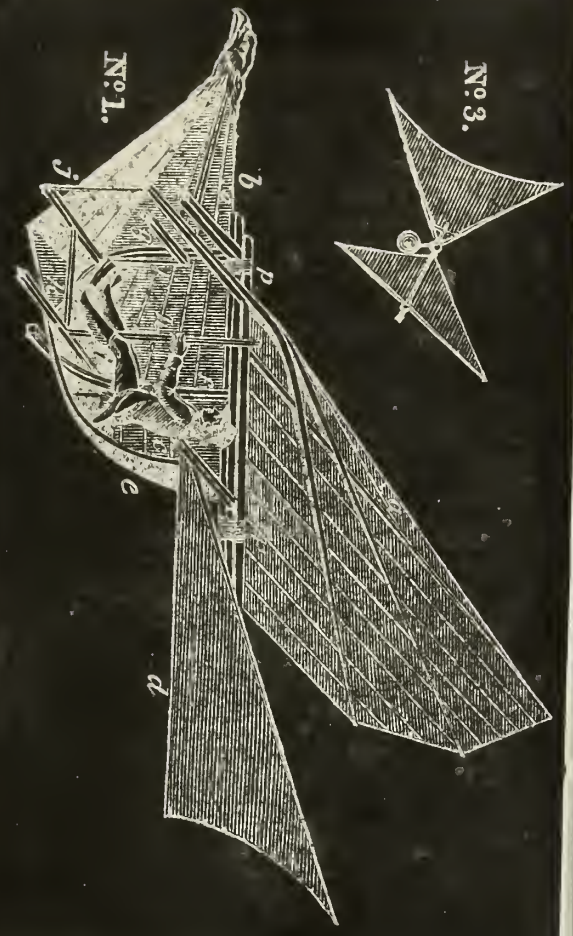
little treatise becomes obvious, more particularly so if we take into consideration the various purposes to which artificial flying may be applied.

When my work was just ready for the press, I was much suprised at the account a friend gave me of what he had seen that day upon flying, in a monthly journal. I immediately procured a sight of it, and found it to be an ingenious paper, written by Sir George Caley; and I own I was astonished at the perusal. I conceived it to be very extraordinary, that two persons, not having the least knowledge of each other, should be publishing their thoughts at the same time, upon such a subject; nor was I less surprised to find the subject treated of there, in a manner so rational, and far superior to any thing I had ever seen before. From what Sir George has thought, and the calculations he has made upon the subject, he is so sanguine in his belief, that flying will be effected, as to say, in one part of his paper, as follows: "I feel perfectly confident, however, that this noble art will soon be brought home to man's general convenience, and that we shall be able to transport ourselves and families, and their goods and chattels, more securely by air than by water, and with a velocity of from 20 to 100 miles per hour." Vide Nicholson's Journal, for November, 1809.

For my own part, whatever reason I may have to be sanguine of success, I have made a resolution to suppress in my work, every thought that confidence could suggest, beyond what I could give demonstration of, along with the clearest di-

rections how to attain the end in view; thereby putting it out of the power of critics to say that the principles of my theory have not a good foundation.

Notwithstanding, from the novelty and singularity of the subject, I do expect to meet with a good deal of railery and sarcasm; the wits will tell me that I am flighty, and the more serious and heavy part of mankind, who are too ponderous for such aërial flights, will express a disapprobation of my scheme; but I do not write for such folks, my sole aim is to deliver my thoughts to the public, in hopes that men of genius and science may turn their attention to a subject that may not before now have attracted their notice, that, by their aid and assistance, the art may be brought into practice; and as this country stands unrivalled in arts, I hope we shall not be long without a society for the encouragement of the art of flying. Columbus was laughed at when he talked of a continent beyond the Atlantic; but flighty as he might appear, he found it; and *wise* men lost it!



DESCRIPTION

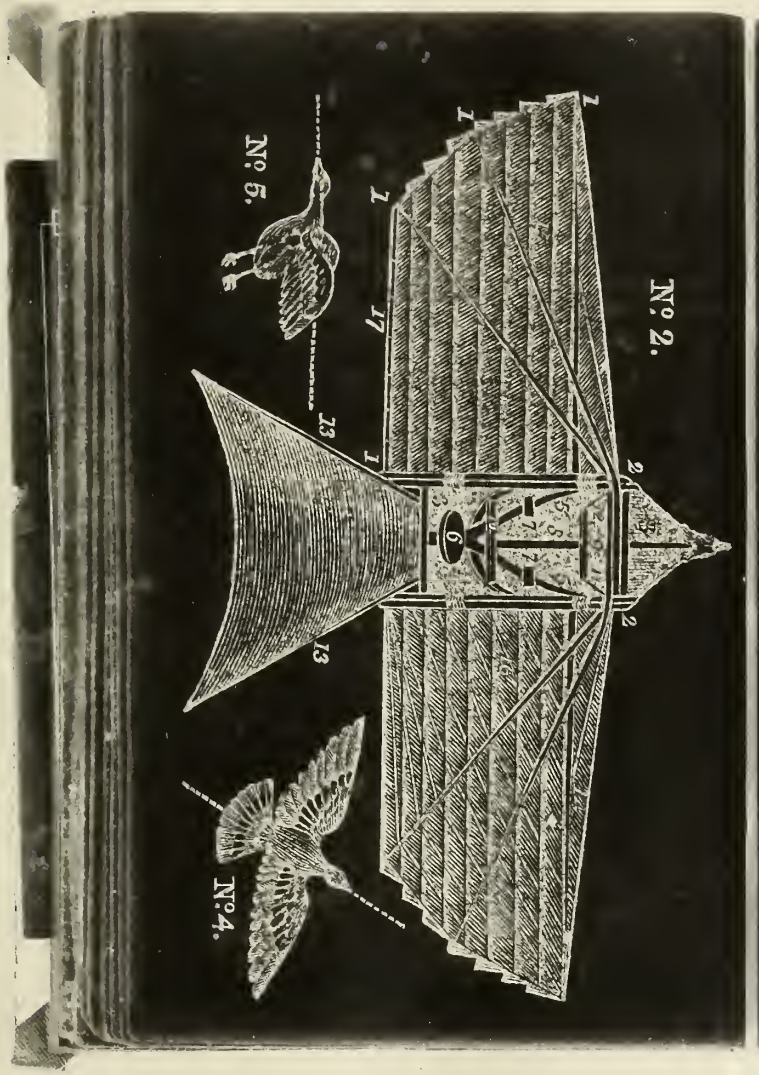
OF

THE PLATES.

THE SECTION OF THE CAR.

No. 1. *a* The right wing.—*b* One of the side rails, upon which the wing must work with two joints to admit of a vertical motion, for no other motion can answer the purpose. *c c* The two cross bars which hold the side rails together.—*d* Half of the tail.—*e* The back rib, fixed to the middle of the hinder cross bar, and then brought down to the bottom of the middle rib.—*f* The middle rib, fixed to the two side rails, and *bended* down three feet below, to form the bottom of the car.—*g* One of the fore ribs, fixed to the fore corner of the car on the right side, and then to the back rib at the bottom.—*h* The upright lever, fixed into the crank, to move the wings with. *i* The axis for the crank to work upon, which must be placed two feet nine inches below the top edge of the car.—*j j* Two iron rods two feet nine inches long, to unite the inner ends of the wings to the ends of the crank head.—*k* Two oblique prongs to be fixed to the back rib, projecting forward, with the points twenty inches asunder, and fifteen inches below the crank when it stands in a level direction. They are to keep extended the fore part of the bottom of the car, so as to admit of room for the crank head to work up and down.—*l* The crank, two feet six inches long; this causes the wings to strike up and down, by means of the man working the

lever backwards and forwards.—*m* The crank head, eighteen inches long —*n* The seat for the man to sit upon, fixed to the back rib —*o* A piece of wood projecting from the middle of the fore cross bar, to which is fixed a head made of cork-wood, and a number of small cords to be stretched to the two fore ribs, and the prongs at the bottom of the car; in the same manner cords are to be fixed all round the car, to support the silk which covers the outside.—*p p* Two joints which fasten the wings to the edge of the car.



PLAN OF THE CAR.

No. 2. 1 1 1 1 The shafts of the left wing.—2 2 The two side rails which form the top edges of the car, and upon which the wings are to be fixed with two joints each. 3 3 Two cross bars three feet each, holding the two side rails together.—4 The middle rib with its two ends fastened to the side rails, bending down in the middle, so as to form the bottom of the car three feet below the top rails.—5 5 The two fore ribs to be united to the fore ends of the side rails, and to bend down to the middle rib, at the bottom of the car, and there joined to the back rib, which must have its upper end well fixed to the hindermost cross bar.—6 The seat for the man to sit upon, fixed with its front ten inches behind the axis of the crank.7 7 Two foot-boards for the man's feet to rest upon. 8 The crank, two feet six inches long.—9 The head of the crank, eighteen inches long.—10 The axis of the crank, eighteen inches long.—11, 12 Two iron rods, fixed with joints to the two inner ends of the wings, and then to the two ends of the crank head.—13, 13 Two shafts to give expansion to the tail.—14 Small cords to brace the fore shaft of the wings.—15 Eight longitudinal parallel cords, well stretched, to which slips of silk must be sewed, each slip about seven inches broad; and the oblique cords, 16, must be well stretched and knotted to them at each part where they cross.—17 A number of small threads, running across the under side of the wings at about four inches asunder, to which each slip of silk must be attached, that they may be prevented from opening more than half an inch from each other when the wings move upwards.

No. 3. A pair of paper wings, ten inches each in length, with a tail ten inches long down the middle; the frame or skeleton of the wings and tail to be formed of small sticks, about the thickness of a crow quill, and the

paper must be fixed on by its edges being neatly pasted to the sticks; at the posterior angle of the wings the *paper* must have a piece of fine thin cloth pasted upon it to give strength to it at the corner.

No. 4. Represents a pigeon flying from the ground in the angle of sixty.

No. 5. Represents a grebe flying horizontally.

THE

Art of Flying.

WE learn, from several authors, that, in different ages of the world, the art of flying has been attempted by various means, all of which have hitherto failed of success. When we take into consideration the different methods which are recorded to have been tried, we cannot be surprised that they have all failed, since, compared with what is contained in the following pages, they will obviously appear to be nothing more than mere whims and contrivances, all utterly destitute of the true nature and science of flying.

I am conscious that many of my readers, who have never been led to notice the remarks that many eminently learned men have made upon this art, will be tempted at the first sight of my titlepage to ridicule a treatise upon artificial flying; for there is not a more common saying, when a person has taken some great difficulty in hand, than that such a thing is as impossible to be done

as for one to fly in the air. I do assure all such, that my treatise is not founded upon a whim of the moment, but from mature deliberation on the display of nature. The study of the works of nature has been to me, during the greatest part of my life, a source of amusement and inexpressible delight. The natural history of birds has particularly occupied my attention, and that enviable faculty which they possess of flying, has greatly excited my curiosity, and led me to that study by which I have obtained a *true knowledge* of the mechanical principles by which they fly; a knowledge which I do not hesitate to declare has hitherto remained undiscovered, although it has been the object of the study and contemplation of the most eminent philosophers of past ages.

That great observer of the works of nature, Solomon, did not overlook the subject of flying, but speaks of it in his book of Proverbs, xxx. 18, 19, "There be three things which are too wonderful for me, yea, four, which I know not; *the way of an eagle in the air*, the way of a serpent upon a rock," &c. I beg also to remind such of my readers as doubt the possibility of flying, that many useful and valuable mechanical inventions, which are now rendered complete, and become common, would, a century or two past,

have been treated as visionary and impracticable; or had they been accomplished at such periods, their effects would have been attributed to witchcraft. I have not the least doubt of being successful in the art of flying, if I had it in my power to give it a fair trial. My invention for attaining the art is founded *entirely upon the principles of nature;* and although these principles are as old as the creation, they have never, until now, been properly attended to. How much are we indebted to the study of nature for discoveries of the greatest importance? and from this delightful study many more are yet to be expected.

The love of pleasure is natural to man, and to gratify this propensity he eagerly attends to every artificial entertainment that is offered to him; he resorts to theatres and operas, to New-market and other haunts of vanity and folly, as if pleasure were nowhere else to be found; at the same time, what an inexhaustible fund of entertainment is overlooked by all but a few, although constantly displayed in the wonderful exhibition of the works of nature.

What a pity it is that the minds of men are not more generally and forcibly struck with the pure and tranquil delights resulting from the universal study of nature. What

riot, confusion, waste of time, loss of money, and of health, might be avoided, if this pleasing and truly enlightened study could be made fashionable. What an infinite stock of ideas it would create; how much it would enrich the human mind, and afford matter for social conversation and entertainment far superior to the unimportant subjects which too generally occupy the minds and tongues of men.

I will now present my readers with some account of various schemes which have been tried to accomplish the art of flying, and shall shew the cause of their insufficiency. I shall explain the natural mechanical means by which birds are enabled to fly, and my readers will then be able to judge how far my invention for flying corresponds with the natural science, and is thereby calculated to succeed. I shall shew likewise the comparative difference between the specific gravity of the humming bird and the condor; also, the different expansion of the wings. I shall compare the weight of a man with the weight of the condor, and thereby determine the necessary dimensions of a pair of wings which would enable a man to fly; and lastly, I will explain an experiment which I have made, in order to demonstrate the principles of artificial flying, and give direc-

tions for making a machine wherein a man may sit, and, by working a pair of wings with a lever, be able to ascend into the air, and fly with as much safety and ease as a bird. Vide plate I.

During the early part of my life I have dissected a great many birds, and since studied very minutely the mechanism of their wings, tails, and all the parts which they employ in flying.

I have long been accustomed to contemplate a bird as a living machine, formed by the Almighty Creator, either to run upon the earth, to dive in the waters, or to ascend into and fly through the air; and when I examine its various parts, and find such an exquisite display of wisdom, in each being formed so perfectly to answer the use it is applied to; when I see the effect of the whole, that such a wonderfully organized, animated piece of matter, can quit the earth and soar aloft in the air, it appears to me a miracle, and I am struck with admiration.

It is now almost twenty years since I was first led to think, by the study of birds and their means of flying, that if an artificial machine were formed with wings, in exact imitation of the mechanism of one of those beautiful living machines, and applied in the very same way upon the air, there could be no

doubt of its being made to fly ; for it is an axiom in philosophy, that the same cause will ever produce the same effect.

It is easy to demonstrate, that a bird is no more able to fly than a man, without the mechanical effect of wings ;* therefore, when a man is furnished with a pair of wings large enough, and can apply them in the same manner as a bird does, and with sufficient power, there can be no reason to doubt of a man being able to fly as well as a bird. The machine which I have planned is as close a copy of the natural mechanism of a bird as artificial means will admit of; and when my readers are made thoroughly acquainted with both the natural and artificial means of flying, I flatter myself they will then be willing to acknowledge that my scheme is a very rational one, highly calculated to insure success in the accomplishment of the art of flying, one of the most extraordinary and desirable arts with which we can be acquainted.

* The ostrich, in the torrid regions of Africa ; the emu, in the extensive plains of Paraguay, in south America, which standing erect, is about seven feet high, its legs are three feet long, its thighs are nearly as thick as the thighs of a man ; it runs so swift that the fleetest dogs are foiled by it ; the cassowary and the dodo, in the Molucca Islands ; and the penguin, in the straits of Magellan and the South Sea Islands ; all these birds are as utterly incapable of flying as a man, none of them being provided with wings for that purpose.

Although I have, for many years, been extremely anxious to bring the machine into effect, and am very sanguine in my expectations of success, (for I positively assert, that flying cannot be accomplished on any other plan than the one I propose,) I, unfortunately, have ever found myself unable, from my professional avocations and other circumstances, to put it in practice, or I should long since have made the experiment.

Finding, therefore, that to no purpose I have deferred, for a long time, its execution, which I deeply regret ; and the prospect of the future being not more favourable, I am induced to publish my plan, in the hope that the lovers of the arts and sciences, when I have laid before them a scheme so practicable, will readily be induced, for the honour of science and our country, to contribute to the means of bringing it into practice ; and demonstrate to their fellow mortals, how they may gain a perfect dominion over any other element.

In almost every nation where arts and sciences have flourished, persons have manifested a wish to discover the art of flying. In Rome and Paris particularly, different persons, and in ages remote from each other, have tried experiments with wings formed of various materials, which have been fastened

to their arms ; but none of them succeeded, there not being strength sufficient in a man's arm to enable him to fly with detached wings fastened to him, leaving the whole weight of his body unsupported.

Friar Bacon, who lived nearly five centuries ago, wrote upon the subject, and he affirms that the art of flying is possible ; and many others have been of opinion, that by means of artificial wings affixed to the arms or legs, a man might fly as well as a bird.

The philosophers of the reign of king Charles the Second, were much engaged with this art. The famous bishop Wilkin, who, in 1672, published a treatise upon flying, was so confident of its practicability, that he says, he does not question but that in future ages it will become as common to hear a man call for his wings, when going a journey, as it is now to call for his boots and spurs.

In the year 1709, as we gather from a letter published in France in 1784, a Portuguese, Friar de Gusman, applied to the king to encourage him in the invention of a flying machine. The principle upon which it was constructed, if indeed it had any principle, seems to have been that of a paper kite ; the machine was in the form of a bird, and contained several tubes through which the wind was to pass in order to fill a certain sail,

which was to elevate it ; and when the wind was deficient, the same was to be effected by means of bellows concealed within the body of the machine. The ascent was also to be promoted by the *electric* attraction of pieces of amber placed in the top, and by two *spheres* inclosing *magnets* in the same situation.

These silly inventions shew the very low state of science at that time in Portugal, especially as the king, in order to encourage him in his further experiments in such an useful invention, granted him the first vacant place in his college of Barcelos, or Santerim, with the first professorship in the university of Coimbra, and an annual pension of 600,000 reis, during his life. Of this De Gusman, it is also related, that, in the year 1736, he made a wicker basket of about seven or eight feet diameter, and covered it with paper, which raised itself about 200 feet in the air, and the effect was generally attributed to witchcraft.

Mr. Willoughby, after observing that the pectoral muscles of a man, in proportion to his weight, are many degrees too weak for flying, recommends to him who would attempt the art with the desire of success, to contrive and adapt his wings in such a manner, that he may work them with his legs and

not with his arms, because the muscles of the legs are much stronger.

The celebrated lord Bacon wrote on the subject of flying, and believed it practicable, but it seems that he could no more direct how it was to be done than any other who had written before him on the same subject.

Thus much, for the satisfaction of my readers, I have thought proper to make mention of what has been attempted in the accomplishment of this wonderful art; but were I to adduce all that has been said and done, at different periods of time, I could compile a large volume of that alone, which would answer no other end than that of curiosity, and to shew that no one has ever understood the natural means of flying, which is the only knowledge that can guide us to the completion of artificial flying, and which I hope and trust will be clearly demonstrated in this treatise.

As I shall have occasion to refer to various birds, possessing different powers of flight, in illustration of my design; I here introduce the history of the candor, for the information of such of my readers as may not be acquainted with it.

The condor is a native of America, and hitherto naturalists have been divided whether to refer it to the species of the

eagle, or to that of the vulture. Its great strength and activity, seem to give it a claim to rank among the former, whilst the baldness of its head and neck is thought to degrade it to a rank amongst the latter. It is, however, fully sufficient for our plan to describe its manners, form, weight, expansion, and power, we will therefore leave to nomenclators to decide upon its class. If size, for it is by much the largest bird that flies, and strength, combined with rapidity of flight, and rapacity, deserve pre-eminence, then no bird can be put in competition with it; for the condor possesses, in a higher degree than the eagle, all the qualities that render it formidable, not only to the feathered tribe, but to beasts, and even to man himself.

Acosta, Garcilasso, and Desmarchais assert, that it measures eighteen feet across the wings when expanded: its beak is so strong as to pierce the body of a cow; and it is positively asserted that two of them are capable of devouring that animal. They do not even abstain from attacking man himself; but fortunately there are but few of the species. The Indians say that they will carry off a deer, or a young calf in their talons, as an eagle would a hare, or rabbit; that their sight is piercing, and their manners terrific. According to modern authors

they only come down to the sea-coast at certain seasons, particularly when it is supposed their prey fails them upon the land; that they then feed upon dead fish, and such other nutritious substances as the sea throws upon shore.

Condamine says, he has frequently seen them in several parts of the mountains of Quito, and has observed them hovering over a flock of sheep; and he thinks they would, at one particular time, have attempted to carry some of them off, had they not been scared away by the shepherds. Labat says that this bird has been described to him, by those who have seen it, as having a body as large as a sheep, and that its flesh is as tough and disagreeable as carrion. The Spaniards, residing in that country, dread its depredations, there having been *many instances of its carrying off children.* Mr. Strong, the master of a ship, relates, that, as he was sailing along the coast of Chili, in the thirty-third degree of south latitude, he observed a bird sitting upon a high cliff near the shore, which one of the ship's company shot.—They were greatly surprised when they beheld its magnitude; for when the wings were extended, they measured thirteen feet from one tip to the other; one of the quill feathers was two feet, four inches and three quarters

in length, and an inch and a half in circumference.

Mons. Feuilleé, whose description alone is accurate, has given a still more circumstantial account of this amazing bird.

In a valley of Illo, in Peru, says he, "I discovered a condor perched on a high rock, before me; I approached within gun-shot and fired; but as my piece was only charged with swan-shot, the lead was not heavy enough to bring the bird down. I perceived, however, by its manner of flying, that it was wounded; and it was with a good deal of difficulty that it flew to another rock, about five hundred yards distant on the sea-shore. I therefore charged again with ball, and hit the bird under the throat; which made it mine. I accordingly ran up to seize it; but even in death it was terrible, and defended itself upon its back, with its claws extended against me, so that I scarcely knew how to lay hold of it. Had it not been mortally wounded, I should have found it no easy matter to take it; but I at last dragged it down from the rock, and with the assistance of one of the seamen, I carried it to my tent, to make a coloured drawing of it. The wings of the bird, which I measured *very exactly*, were twelve feet three inches (English) from tip to tip. The great feathers, which were of a beautiful

shining black, were two feet four inches long. The thickness of the beak was proportionable to the rest of the body; the length about four inches; the point hooked downwards, and white at its extremity; and the other part was of a jet black. The thigh bones were ten inches long, the legs five inches, the toes and claws were in proportion; and the legs were covered with black scales. The little nourishment which these birds find on the coast, except when a tempest throws up some great fish, obliges the condor to continue there but a short time. They usually come to the coast at the approach of evening, stay there all night, and fly back in the morning."

I now proceed to describe the construction and application of the wings of a bird. How properly are they formed to fulfil the uses they were made for! The first is to expand, and by that means to give the bird a secure hold upon the air below it, which hold is always in proportion to the dimensions of the wings. The tail produces the same effect. We see that by means of a pair of wings and a tail duly expanded, in a perfectly *passive state*, and aloft in the air, without any muscular motion, a bird procures a suspending power, which counteracts the specific gravity of its body, and prevents its

being precipitated to the ground; such is the effect of the wings and tail when in a passive state.

I will next take some notice of the quill feathers, which are replete with proofs of the wisdom of the almighty Artist who made them. As they were intended to swim with in so light and subtle a fluid as the air is, it was necessary that they should be formed of the lightest materials imaginable; and as they were intended to strike upon the air with great power and rapidity, it was requisite that they should possess, in the shafts, great strength with elasticity; it was expedient too, that the quill feathers should separate and open, to let the upper air pass through the wings, to facilitate their ascent, when they are struck upwards; it was also necessary that they should all shut close together, forming each wing into a complete surface or web, when they are, by the muscular power of the bird, forced down, in order to give a more secure hold upon the air below, and by that means keep the bird up.

Now if we do but examine the quill feathers, we shall find in the shafts astonishing strength with elasticity, and very little specific gravity indeed. The webs of the quill feathers are broader on one side of the shafts than the other, which causes them to open

as the wings move up, and to shut as they come down, exactly answering the purposes I have already mentioned; therefore, we see how wonderfully complete the wings are in all their parts, and how effectually they serve all the uses required.

I will now show the application and effect of the wings and tail in an *active* state.—When a bird, by the power of its pectoral and deltoid muscles, puts its wings into action, and strikes them downwards in a perfectly vertical direction upon the air below, that air being compressed by the stroke of the wings, makes a resistance, by its elastic power, against the under side of the wings, in proportion to the rapidity of the stroke and the dimensions of the wings, and forces the bird upwards; at the same time, the back edges of the wings being more weak or elastic than the fore edges, they give way to the resisting power of the compressed air, which *rushes upwards past the same back edges*, acting against them with its elastic power, and thereby *causes a projectile force*, which impels the bird forwards; thus we see that by one act of the wings the bird produces both *buoyancy* and *progression*. When the tail is forced upwards, and the wings are in action, the bird ascends, and forced downwards it consequently descends;

but the *most important use of the tail is to support the posterior weight of the bird*, and to prevent the vacillation of the whole.

Thus having discovered and explained to my readers, the natural mechanical means by which birds accomplish flying, they will be able to see that the plan upon which I have formed my scheme for artificial flying, is perfectly analogous to the principles of nature, which certainly ought to be clearly understood, and taken as our only guide, before we can ever expect to arrive at success in the art of flying; but with the knowledge of these principles, *there cannot remain a doubt of success*.

When we first think of a man attempting to fly by mechanical means, we are induced, considering his specific gravity, to pronounce it impossible; and had we never seen or known of any bird larger than a humming bird, whose weight does not exceed one drachm, and whose diminutive wings measure only three inches from tip to tip; and were to be told by some traveller, that he had seen a bird with a body as large as a sheep, that had wings of twelve feet expansion, and that it could quit the earth, and ascend into the air with its ponderous body, and there fly about with as much ease as the little humming bird; we should think it too

marvellous a tale to be credited. But as we are accustomed to see, almost every day, birds of such various dimensions and specific gravity, as are exhibited by nature, from the humming bird to the common wren; from the wren, through a numerous gradation, up to the eagle, we can readily give credit to the history of the wonderful condor, in South America, whose existence is so well attested that we can have no reason to doubt of it; more especially as we witness so vast a gradation in the indigenous birds of our own country. I believe, that there were two of these prodigious birds in the Leverian Museum.

The following observations upon the wonderful difference in the weight of some birds, with their apparent means of supporting it in their flight, may tend to remove some prejudices against my plan, from the minds of some of my readers. The weight of the humming bird is one drachm, that of the condor not less than four stone; now if we reduce four stone into drachms, we shall find the condor is 14,336 time as heavy as the humming bird. What an amazing disproportion of weight! Yet, by the same mechanical use of its wings, the condor can overcome the specific gravity of its body with as much ease as the little humming bird.

But this is not all; we are informed that this enormous bird possesses a power in its wings, so far exceeding what is necessary for its own conveyance through the air, that it can take up, and fly away with a whole sheep in its talons, with as much ease as an eagle would carry off, in the same manner, a hare or a rabbit. This we may readily give credit to, from the known fact of our little kestril, and the sparrow hawk, frequently flying off with a partridge, which is nearly three times the weight of either of these rapacious little birds.

Let us attend to this subject a little further; let us consider these wings of the condor, which, with a *mechanical action alone*, produces a power that is capable of carrying through the air both the bird and the sheep, weighing together not less than ten stone, which would then be 204,000 *times the weight of the humming bird!* When this is duly considered, with reference to my plan, what encouragement does it not give to prosecute the art of flying? particularly so, when we consider that a man of ten stone weight, in a machine weighing two stone, will only exceed the weight of the condor *one-fifth part*; this is a mere trifle compared with the astonishing difference there is between the humming bird and the condor.

The condor carries ten stone, with wings of twelve feet expansion from tip to tip ; the humming bird carries one drachm, with three inches expansion ; the common wren is three times as heavy as the humming bird, and has but one inch more of wing ; a pigeon weighs sixteen ounces, which is 256 times as heavy as it is, and has only ten times more expansion of wing ; the goatsucker is forty times as heavy, and has seven times the length of wing. I could here carry the same observations upon other birds to a very great extent, but the above are instances sufficient to prove that birds' wings are not multiplied in their length in the same proportion with the increased weight of their bodies : therefore, as a man weighing ten stone, and his machine two, as I have already shewn, will only exceed in weight one fifth part of the weight of the condor and his prey ; and as the wings of the condor are about twelve feet, suppose we make a pair of wings of silk, one fifth longer than they are, which will be about fourteen feet and a half, I am thoroughly persuaded they will be found amply sufficient, as they will far exceed the progressive increase of birds' wings.

By attending to the progressive increase of the weight of birds, from the delicate little humming bird up to the huge condor, we

clearly discover that the addition of a few ounces, pounds, or stones, is no obstacle to the art of flying ; the specific weight of birds *avails nothing ;* for by their *possessing wings large enough*, and *sufficient power to work them*, they can accomplish the means of flying equally well upon all the various scales and dimensions which we see in nature.

Such being a *fact*, in the name of reason and philosophy, why shall not a man with a pair of artificial wings, *large enough*, and with *sufficient power to strike them upon the air*, be able to produce the same effect ?

I shall, after a few observations, proceed to describe how a machine may be made with a pair of wings, and a lever to work them with, so that any person will be able to see how far it is calculated to answer the purpose for which it is intended. This machine may be considered as a large artificial bird, and the man placed in the inside as the vital or moving power. All the attempts hitherto made in the art of flying, by different persons, according to historians, have been mere childish whims, not in the least degree calculated to insure success ; they each made a pair of detached wings, some of silk, some of leather, and some of sheet iron, and various other materials ; they fast-

ened them upon their shoulders or arms; thus equiped, they placed themselves upon some eminence, such as a high tower, or a church steeple, then took to their wings; but few of them were fortunate enough to escape without some injury.

It is utterly impossible for a man to fly, with a pair wings fixed to his shoulders or arms, with the whole weight of his body hanging down, and depending entirely on his pectoral muscles for support. These muscles in a man, are many degrees too weak to keep extended a pair of wings of sufficient expansion to effectually counteract the specific gravity of his body. Let a man suspend the weight of his body, with his arms extended, holding to an horizontal beam by his hands, and he will very soon find the insufficiency of the strength of his arms to support his weight. On the plan which I have conceived for flying, the want of strength in the arms is amply provided for. By furnishing a man with a car to sit in, the whole weight of his body is supported by it, and as he sits much in the same manner as if he were rowing a boat, he is enabled to bring into action his *whole bodily strength*, which *far exceeds* the strength of his arms only; and by sitting in such a position, his strength can be exerted with a far greater

force than in any other attitude whatever; he at the same time gains an *additional advantage*, in this plan of mine, by exerting his strength upon a lever.

The two greatest requisites for accomplishing the art of flying, are these; first, *expansion of wings large enough* to resist, in a sufficient degree, the specific gravity of whatever is attached to them; second, *strength enough* to strike the wings with a sufficient force to complete the buoyancy, and give a projectile motion to the machine. With these two requisites combined, *flying* must be accomplished; and, upon my plan, there can be no doubt of wings being made as large as ever they may be wanted; neither ought we to doubt of a man's ability, exerting himself in the way I have described, to bring into action as great a degree of strength, in proportion to his weight, as the condor is possessed of. Therefore, if we are secure of these two requisites, and I am very confident we are, we may calculate upon the success of flying, with as much certainty as upon our walking.

When I first thought of artificial flying, it occured to me, that it would be of some importance, to try what effect a pair of wings would have upon the air, without any mechanical power to work them; I thought that

if I were to suspend a weight from beneath them, and they should prevent that weight from falling in a perpendicular line to the ground, they would demonstrate that the ideas I had conceived of the cause of the projectile motion of birds were well founded.

I therefore made the following experiment, to which I call the *particular* attention of my readers ; as it *positively* demonstrates the cause of the projectile motion. I made a pair of small wings, of fine paper, and very small slips of wood to keep them extended, and fixed on a tail of the same materials, imitating, as near as I could, the wings and tail of a bird, when expanded in a *passive* state. I then suspended a small weight from under them, with a piece of thread, exactly in the centre of gravity ; I held them up as high as I could reach, then took away my hand and left them flat upon the air, without giving any impulse to them whatever; and by the weight pressing downwards, the air under the wings became in some degree compressed, and by its reaction against the under side and the back edges of the wings, *they were projected with an oblique descent from one end of the room to the other, carrying the weight all that distance*, which without the wings being of this particular construction, could not have been done.

I had cause sufficient to exult in the success of my experiment, which proved to me, in a very satisfactory manner, that what I had conceived to be the cause of the projectile motion of birds, *was really the cause*, and that if I could but give a vertical motion to the wings, so that they might strike upon the air with a sufficient force, they would then increase the reaction of the air, and instead of being projected in an oblique descent, totally overcome their specific gravity, *and continue flying in a horizontal direction.*

This is an experiment which any of my readers may make trial of for their own satisfaction and amusement; and that they may be better able to comprehend me, I have given a representation of it in the plates annexed. Vide plate 3.

Another experiment, serving to shew the different effect of buoyancy obtained by a parachute, and by my paper wings, may be tried in the following manner. Take two straight sticks, neatly dressed, about the thickness of a crow-quill, and each about sixteen inches long, lay them across each other in the middle, at right angles, and tie them fast with a piece of thread ; then tie a piece of thread from the ends of one

stick to the other, so as to secure them at right angles; then take a sheet of gauze paper, and fasten all the four corners of it to the four ends of the sticks; but previous to this, paste upon the four corners of the paper four small slips of thin cloth, in order to give sufficient strength; then suspend any small weight by a thread from the centre; let the whole fall from a height, and you will see the effect of a parachute in miniature: but this effect is very different from that of the paper wings; the parachute *sinks gradually down in a perpendicular line*, whilst the wings *dart forwards* to the distance of several yards.

I have met with persons who have boldly asserted that it is impossible for a man to exert sufficient strength to raise himself up into the air by mechanical means alone; but the rashness and fallacy of such an assertion, is completely refuted and exposed by Mr. Degen, in Vienna, who has very lately actualty ascended *into the air*, to a considerable height, by sitting in a machine and giving action to two parachutes; and had he properly understood the principles of birds' wings, and considered the astonishing power in the reaction of the air, which may be *increased in proportion to any force* exerted upon it, *ad infinitum*, and possessed a

complete knowledge of the principles upon which it enables birds to fly, he would have chosen wings and not parachutes, and might then have accomplished flying in perfection.*

There is no doubt, that by large parachutes, worked by a mechanical power, a man may raise himself from the ground, to a considerable height; but that cannot be properly called flying; because, as the compressed air rushes from underneath the parachutes, to regain its equilibrium, *on all sides alike*, there will be no projectile motion effected, without which *there can be no command or steerage*, and in such case the whole apparatus will be driven which ever way the wind impels it; I therefore cannot give credit to that part of the account of M. Degen's performance, which asserts that he flew *in various directions*, although I can readily

* M. Degen, a watchmaker of Vienna, has invented a machine, by which a person may raise himself into the air. It is formed of two parachutes, of taffeta, which may be folded up or extended at pleasure, and the person who moves them is placed in the centre. M. Degen has made several public experiments, and rose to the height of fifty-four feet, flying, in various directions, with the celerity of a bird. A subscription has been opened at Vienna, to enable the inventer to prosecute his discoveries. Vide the Monthly Magazine for September, 1809.

believe in his having raised himself into the air, and think that great praise is due to him. I do not believe it possible, upon his plan, that he could have gone in any other direction than with the wind: but with a pair of wings constructed, and worked, according to the natural principles of flying, a projectile motion is obtained in as perfect a manner as buoyancy, both of which must be accomplished before we can have the benefit and pleasure of flying with *steerage*, and that upon the following plan only, viz.

Make a car of as light materials as possible, but with sufficient strength to support a man in it; provide a pair of wings, of about eight feet each in length, let them be horizontally expanded, and fastened upon the top edge on each side of the car, with two joints each, so as to admit of a vertical motion to the wings, which motion may be effected by a man sitting, and working an upright lever in the middle of the car; a tail, of about seven or eight feet long, and the same breadth at its extremity, must be fixed to the hinder part of the car, and spread out flat to the horizon in the same manner as we see the tails of birds. Vide plate 2.

The grebes, by their manner of flying, evince that the most important use of a bird's tail is *to support* the *posterior weight* of the

body; for the Creator having left the whole of this class of birds, of which we have five different species, indigenous in this country, all totally destitute of any portion of a tail, they are, consequently, always seen, when flying, to have their bodies hanging down nearly in a perpendicular direction, and appear to fly with great difficulty, (vide plate 5;) but this impediment in flying is of little consequence to them, their organization being perfectly adapted to their mode of living. They find their subsistance in lakes and pools, wherein they are incessantly diving, and, of course, are not obliged to fly until those places are frozen up; when they are compelled to flutter off as well as they are able, in search of some spring or swamp which is not affected by frost, where they find a temporary subsistence until their favourite lakes are relieved from a surface of ice; they then return to their former haunts, where they again seem quite in their element. Here we find a class of birds, owing to their want of tails, possessing the power of flight in a very imperfect degree, compared with some birds: it also may be observed, that birds having extraordinary large tails, as the magpie, for instance, do not fly in the best manner; none of these birds possess what seems to constitute the excellence of flying,

viz. soaring and reposing upon the air; this can only be effected when the weight of the body is upon an equipoise in the centre of the wings and tail; each bearing up its due proportion, and the expansion altogether so large, as to bring the whole weight nearly in equilibrium with the atmosphere. This must be properly attended to in the construction of a flying machine.

To give a further security to the power of suspension, a sail of an equilateral triangle may be spread horizontally over the man's head, supported by a small light mast or bowsprit, at the height of three or four feet above the car; the sail must be expanded and fixed to the mast by a very light yard, presenting the base of the sail to the head of the car, with the opposite point towards the tail, and there fastened with a cord to another small bowsprit; this sail will be a protection, if large enough, in case of any accident occurring to the machine; it will then prevent the man from being precipitated to the ground, in a manner similar to a parachute. I have only mentioned this sail, that it may be resorted to, if it be found necessary, in a long voyage; the first experiment I would try without it.

The whole of the machine and wings are represented in the plates annexed. A coach-

maker is accustomed to make strong work with little weight of materials; he, therefore, would be the most proper person to make a machine of this kind. The man must sit in the middle, between the wings and the tail, so as to be a little behind the centre of gravity, for the purpose of causing a little preponderance of weight to act upon the back edge of the wings; for if there be not in some degree, more weight behind than before, when the compressed air is making a resistance against the underside and back edges of the wings, where it rushes upwards again, causing a great reaction, it would, of course, elevate the hinder part of the car too much.

The wings and the tail should be made of silk, very compactly woven, and as impervious to the air as possible. The silk which the wings are formed of, should be laid on in separate broad slips,* and should open to admit the air to pass through as the wings move up, and close together again as they come down, in the same manner as I have described the action of the quill feathers, in

* The tail feathers of turkies laid close and parallel to each other, and fast sewed upon eight pieces of strong ribbaud, so as to form the same number of slips, then extended in the wing and well braced, would perhaps answer the purpose much better.

the wings of birds, (vide plate 2;) although upon the experiment being tried, this method may not be found so absolutely requisite; for we see flying squirrels, bats, butterflies, beetles, flying fish, &c. with wings formed of compact membranes, all flying exceedingly well. The Madagascar bat has a body the size of a rabbit, with wings four feet long, formed of entire membranes, and although so large, it can fly as well as our little native bats; therefore, it is possible, that a pair of artificial wings may be formed without any valves, and yet answer equally well; but this can only be determined by actual trial.

It is necessary to observe, that the car in which the man is to sit, must be entirely covered on the outside with silk or very thin leather; and along each side of the car, the silk or leather must be united to the base of the wings, to prevent, as much as possible, the air from escaping any where but from the back edges of the wings: should that be neglected, when the air is compressed by the wings being struck downwards, it will rush upwards through the car, and thereby fail of giving that resistance against the underside of the wings, which is necessary for the purpose of effecting buoyancy and progression.

I think that the shafts of the wings and

tail would answer the purpose in the best manner, if they were each of them made of six long slips of thin whalebone, dressed tapering to a point, then wrapped together in a round form with small twine, from end to end; and filled with cork along the inside. By making them in this manner, they would spring against the air, would be very light, and so strong, that it would be impossible to break them with the power or weight of any person. By forming them as above, we shall humbly imitate the shaft of a quill feather, which is composed of a thin horny shell, containing a delicate light pith along the inside.

I here recommend my readers to *particularly observe*, that a *main point in this treatise* is, that they should not overlook the importance of the knowledge of the reaction of the air against the underside and *back edges of the wings;* for this is what causes the projectile motion, which is indisputably proved by the flying of my paper wings across a room; and which I will further illustrate by the flight of birds, mill sails, &c.

I have frequently conversed with persons about the art of flying by mechanical means, and generally found them disposed to treat the idea with ridicule; I have asked them if they knew how birds were enabled to fly,

and they mostly answered me nearly in the following manner: that birds could fly because it was natural to them; that they were covered with feathers, which were such light materials as to help them to fly, and that their wings are properly adapted for flying. This was as far as they could explain, which proved that *all* they knew on this subject amounted to nothing. They generally seemed to indulge an idea, that there was something in the flight of birds either supernatural or incomprehensible; but I hope my readers will be convinced, by this little treatise, that the art of flying is as truly *mechanical* as the art of rowing a boat.

I will here further illustrate how flying is effected. The air, when struck upon by wings, produces an effect by its reaction against the underside and back edges, similar to that which is caused by the wind blowing with sufficient force against a mill-sail, when it *rushes off on one side*, and impels the sail to move; with this difference only, that the sail being fastened at one end to an axis, is made to revolve, whilst the bird, being at full liberty in the air, is caused, by the expansive power of the air acting with a resisting force *against the back edges* of the wings, to glide forward in a right line.

Most of my readers, I think, will acknowledge the great elastic power of the wind, as it is manifested by the sailing of ships, and the revolving of mill-sails; these effects are produced by the wind being compressed against the sails, from its own natural motion and force; but the effect the air has against the wings or sails of birds, is produced by its being compressed, with them striking vertically upon it: and the larger they are made, the greater quantity of air is compressed, by which means is caused a more powerful reaction, and consequently, a more effectual buoyancy and progression. From this cause, all the birds whose wings are *very large* in proportion to their weight, are able to fly with the *least exertion* imaginable; whilst birds with very small wings are obliged to use very great labour indeed; this being demonstrated by the examination of the dimensions of birds' wings, and their specific gravity, and by observing their different methods of flying.

I have often been delighted with the striking conviction, that supreme wisdom alone, could have so nicely adjusted all the various internal and external organization of the vast number of different species of birds, to their diversified wants and modes of living; but it is only necesssry to observe here,

that all those which are under the greatest necessity of flying, are provided with the *longest* and *best proportion* of *wings* and *tails*, and are consequently able to fly in the best manner; and those which need them less, have them more limited, and are therefore less capable of flying; as if the all-wise Creator had set limits to their powers of flight, that they might not go out of their respective elements.

Although I think that a pair of wings seven or eight feet each in length, would be sufficient; still if I could make it convenient to try the experiment of flying, and were not prevented, as I am, by a chain of untoward and uncontrolable circumstances, I would cause the wings to be made of as large dimensions as I could possibly *move with ease.*

I observe among the aquatic birds, that the auks, guillemots, divers, &c. have such remarkably small narrow wings that they would be utterly incapable of keeping themselves up in the air, if it were not for an exertion which they are obliged to make in the extreme. Their wings are moved with such rapidity, as to be with difficulty discerned. In this we see the economy of the all-wise Creator, for according to their habits and appetites they have very little occasion to

fly at any time, except during the time of incubation, when they have to ascend the most inaccessible rocks and cliffs they meet with along the sea shore, where they breed and rear their young; all the rest of their time they pass on or in the water, swimming and diving for their food.

All the gallinaceous class of birds have very short concave wings, which they strike with great exertion; they also, in general, have but little occasion to fly; their food, which consists principally of grain and seeds, being spontaneously scattered over the earth, they are almost constantly upon their legs, running about to pick it up, and seldom fly but to avoid danger.

On the other hand, rapacious birds, whose appetites induce them to be the greatest part of their time upon the wing, in search of a subsistence which is very precarious, (as every inferior bird, &c. to which they direct their sanguinary attacks, from that love of existence which God has so strongly implanted in all his creatures, will use its utmost skill and activity to elude its destroyer,) are much better accommodated; having wings of large dimensions they can repose upon the air, and project themselves forward with a gentle wafting. This is the class of birds I would copy from in the construction of a

machine for artificial flying. The kite or glead, P, B, Z, (or *milvus* of Lin.) is the best natural specimen that we can find in the British ornithology; this bird has very large flat wings, with a large forked tail, and flies with the least exertion, I believe, of any bird in the creation.

All the hyrundo class of birds are almost constantly flying; they all have bodies of little weight, have large *flat* wings, and fly with great ease. The goat-sucker, which is a species of nocturnal swallow, is admirably constructed for flying with facility.

As I have mentioned aquatic birds, I will here take the opportunity of execrating, with all the indignation of my soul, that savage and brutal amusement which they bring to my mind, and which so many persons frequently practise and take delight in: I mean shooting these harmless and inoffensive birds. Many are the parties who resort to Flamborough head, for no other purpose than gratifying their vanity, by making a display of their dexterity in shooting, and causing all the havoc they possibly can amongst the poor inoffensive birds. Barren must be their minds, and callous their feelings, who can take pleasure in destroying these innocent creatures, which are not in the smallest degree offensive to man when

they are living, nor of the least service when killed. If these *gentlemen* could eat them when they have done shooting, that would be some excuse; but as their flesh is very rancid, these wanton barbarians have no relish for their game. I wish their humanity were as nice as their appetites: they would then not find delight in merely shooting them for sport and cruelty, leaving them, some killed and others wounded, floating on the surface of the sea, whilst their helpless young ones must consequently perish with hunger upon the shelvings of the rocks. Such amusements, surely, are not becoming rational beings, but may give pleasure to semi-rationals.

In the months of May and June, these birds, which, during the rest of their time, are dispersed over various parts of the ocean, are brought by one of the great impulses of nature to assemble at Flamborough-head, in myriads; producing a throng, upon a great extent of cliff, similar to what we see in miniature, in the front of a bee-hive, on a fine summer's day, when there is a perpetual egress and ingress of thousands.

A person who has never seen such a sight, and is capable of deriving pleasure from contemplating the economy, and the works of nature, may find an exquisite gratification in

paying a visit, at this season of the year, to Flamborough-head, without having recourse to wanton acts of cruelty. Will there ever come upon the earth a generation of men, who will despise all pleasures that are either unreasonable or inhuman?

Reason and *humanity* constitute the *only permanent basis* of all human happiness, and the *real* honour and *true* glory of man! without which he is but a compound of folly and madness, and is too often a vile mischievous brute. By a disregard and contempt of these two divine guides, families and nations become distracted, and are made miserable, as we have too amply witnessed in the deplorable and wretched state with which Europe has been so long afflicted, where the appetite of the cannibal has *only* been wanting to complete the brutality of *civilized* nations. But I am departing too much from my original subject; I will withdraw my pen from this sickening view of poor, frail, erring human nature!

After having described how to construct a machine to fly in, which, like the swift, or great black martin, (*apus*, Lin.) cannot fly from the surface of the ground, but must have an elevation to rise from; it becomes necessary that I should give directions how it may be made to ascend. Set two tressels

fast upon the ground, one six feet high and the other four and a half, at twelve feet distance from each other; then lay upon them two or three planks, which will form a stage with an oblique plane, upon which the car must be placed, with its head pointing to the higher end of the stage.

A person may then get into the car, and sit a little behind the centre of gravity, which must be adjusted before the car is placed there; being thus elevated, he will have depth enough on each side of the car to admit of his wings striking upon the air. He must then push the lever forward about eighteen inches from its perpendicular line, the tips of the wings will then rise three feet and a half above the level of their joints; he must then, with a brisk exertion, pull the lever backwards, eighteen inches past the perpendicular line, and the tips of the wings will be struck downwards, passing through an arch of seven feet; and suddenly driving down and compressing the air in that arch, part of which will escape past the back edge of the wings (as I have described before,) making at the same time a reaction which will push the wings forward; and as the car and the wings are first placed on an oblique plane, they will be impelled forwards, making an oblique ascent. The projectile impulse

will naturally force the machine upwards in any angle in which the plane of the wings is laid, something similar to what may be observed in the raising of a common paper kite, except in a right angle, or perpendicular line; but the nearer the angle of ascent inclines to the line of the horizon, the easier will the machine be found to ascend. I believe pigeons can ascend very near in a perpendicular line, but such an ascent would be too incommodious for artificial flying.

When the car is brought to a sufficient altitude to clear the tops of hills, trees, buildings, &c. the man, by sitting a little forward on his seat, will then bring the wings upon an horizontal plane, and by continuing the action of the wings, he will be impelled forwards in that direction. To descend, he must desist from striking the wings, and hold them on a level with their joints; the car will then gradually come down, and when it is within five or six feet of the ground, the man must instantly strike the wings downwards, and *sit as far back as* he can; he will by this means check the projectile force, and cause the car to alight very gently with a retrograde motion. The car, when up in the air, may be made to turn to the right or the left, merely by the man inclining the weight of his body to one side.

When I have seen a man sitting in a chair upon a tight rope, with a table before him, spread over with decanters, glasses, &c. and by his *dexterity alone*, be able to keep himself and all his accommodations exactly balanced there, while he sat smoking his pipe, apparently at perfect ease; I have been induced to consider the art of managing a flying machine, compared with such a surprising display of human dexterity, to be very simple; and see no reason why men should not become as expert in navigating the air as the sea.

As some of my readers, who may have little regard for any thing but the *utile*, may be induced to ask, of what use will flying be, when it is attained? I beg leave, in the way of reply, to give the following hints:—I hope it will be granted, that flying will be of great use, if by such means we can have our letters, newspapers, &c. conveyed to any part of the kingdom at the rate of forty or fifty miles in an hour; or if that numerous class of mercantile agents who are now denominated riders, henceforth be enabled to glide through the air with great expedition, in flying machines; or if a man, by such means, can take a rope to any mariners in distress along the sea coast, and thereby become the happy instrument of saving their lives; and

if the circumnavigator be able to quit his ship, fly and explore the interior parts of a newly discovered island, free from the annoyance and hostilities of its rude inhabitants—but it would be tedious to enumerate all the uses to which artificial flying may be applied: it is obvious enough, that when one man is enabled to fly, thousands may do the same, either on business or pleasure. It may tend greatly to reduce the vast number of horses kept in this kingdom, and by that means a *very great quantity* of land, which is taken up at present in growing hay, oats, and beans, for the support of these quadrupeds, might be then cultivated for the increase of our national stock of subsistence for the population; and I think it is evident that we have great occasion to reduce the superfluous number of those animals, and to employ all the land we possibly can to grow corn, &c. for our own subsistence. It is not improbable, that some persons will ask, if flying and all this can be accomplished; to which I answer, that if my scheme for attaining the art be deemed a rational one, as I hope it will, I think we certainly ought to try the experiment.

After the perusal of this work, I hope my readers will be fully convinced, that all attempts which have been hitherto made in

the art of flying have failed, not in consequence of the art being impracticable, but from the natural science of flying having never yet been fully understood. All that has ever been written, and all the experiments that have ever been made towards attaining a knowledge of artificial flying by mechanical means, display a chaos of unsettled thoughts very wide and deficient of the principles of nature; but I hope it will be granted, that I have clearly discovered and demonstrated the whole of those principles upon which flying depends, particularly the cause of the projectile motion of birds. This is a discovery of the greatest importance, for as the air is continually acting, in the manner I have described, against the back edges of the wings, and thereby impelling the bird forwards with great force, *it positively has as much tendency to overcome specific gravity as the expansion of the wings has.* This is a fact demonstrated very clearly by my paper wings, and by the manner of flying peculiar to some birds, particularly the woodpeckers. When one of these extraordinary birds has struck its wings once or twice upon the air, and thereby produced a projectile impulse sufficient to force it forward to a considerable distance, it instantly contracts its wings *as close to its*

sides as when perched on a bough, and continues flying several yards with its wings kept *close* in that position, until the impulse is abating; it then throws out its wings again, gives another stroke or two to renew the impulse, *shuts them up*, and is again driven forward; thus continuing to fly by distinct and separate projectile impulses alone. Here then we see the great importance of a true knowledge of the *cause* of the projectile motion of birds, for this surprising bird does not depend upon a continued expansion of wings, to keep itself up in the air, but is kept up and carried forward by the projectile force alone!

The green woodpecker is about the size of a pigeon, and as it is very common in every part of England where wood abounds, many of my readers may have an opportunity of observing its curious method of flying; the same may be observed of the beautiful little goldfinch, and of linnets. Here the physico-theologist, who is accustomed to contemplate the wisdom of God in all his works, might be led to infer that he has caused this deviation from the general method of flying, in order to demonstrate to us the *effect* of the *projectile force*, and that it is one of the *greatest essentials* in the art of flying, and perfectly distinct from, and independent of the continued expansion of wings.

When we see pigeons flying *upwards* in the angle of *sixty* or *seventy*, as we do every day, from the streets to the tops of houses, with the plane of their wings parallel to the line of their ascent; I think they prove in a satisfactory manner, the great effect of the *projectile force;* for, without we admit this to be the cause of their ascending in such angles, how can we possibly account for it in any other way, upon rational principles? Vide plate 4.

A stone thrown by the hand, and a ball ejected from the mouth of a cannon, are made to overcome specific gravity, and fly to a great distance; we all know that these are not kept up by wings, but entirely by the projectile force. In fact, it is by the air being made continually to push the bird forwards, which constitutes the main cause of flying.

We must attribute to a total ignorance of the fundamental principles, that the art of flying has not been brought hitherto into common practice; for an art, so practicable as it is, must at any period of time have soon succeeded a discovery, such as I have made; and now, that the art appears so very attainable, I hope that every friend to arts and sciences will acknowledge that it ought to have a fair trial.

I shall now conclude my treatise on flying with an appeal to the candour and good sense of my readers, whether the arguments I have used, and the principles upon which I have insisted the art of flying may be accomplished, are not such as give it a just claim to their approbation; for I think I may affirm, without being accused of arrogance, that the art of flying has never before been treated of upon such rational and scientific principles.*

* I will here take the liberty of communicating a few hints, which I conceive to be of importance to the aerostatic science. Now that we know the true cause of the projectile motion of birds, and I having suggested a plan for producing the same effect by artificial means, we may be able to accomplish what Messrs. Roberts, Blanchard, and others attempted to do, but in vain, entirely from their not possessing a knowledge of this mystery of nature. I am alluding to the steerage of balloons, which they endeavoured, with great labour to attain, by striking a number of oars *horizontally* against the air; and if we do but take into consideration that the balloon was constantly flying from the air against which they were striking, it does not seem probable that they could, by such means, produce the effect they aimed at.

But if we make a car from the plan which I have laid down in this treatise, and upon a scale large enough to admit one of Messrs. Mead and Co's new invented revolving steam engines, to move the lever with, we then can work, in a *vertical direction*, a pair of *very large wings*, which would produce a *projectile force* sufficient to impel the balloon forwards in any point of the compass to

Having now submitted to the good sense of my countrymen, the whole of what I intended on the subject of flying, I for the present, most respectfully take my leave of them, indulging a hope that the prediction of bishop Wilkins, expressed in a former page, will soon be verified, and trusting that I shall not be disappointed in the opinion I entertain respecting the patronage which they will extend towards the invention now laid before them. Encouraged by the public, I shall not abandon my purpose of making still fur-

which we might incline it; and by having a large tail fixed to the car, in an universal joint, we should be able to give it any inclination whatever; and when we have thus effected a perfect steerage to balloons, we shall be able to convey a number of passengers to any place of destination with accuracy and safety. But for this kind of navigation the balloon must be much smaller than usual, and perfectly spherical, and the gas should be kept in such a degree as not to have too great a tendency to ascend—it should be so regulated as to float in equilibrium with the atmosphere; the aeronauts could then keep the machine at a moderate height—from fifty to a hundred feet would be high enough for ordinary sailing, and if it was found to be inclining too much upwards, it might be counteracted by holding the tail in a descending direction. One of Mr. Mead's patent steam engines can be made with a one horse power, or equal to the strength of eight or ten men, that will not weigh more than eight stone; and will stand in the small space of four feet by two, with the boiler and all the apparatus belonging to it.

ther exertions to advance and complete an art, the discovery of the *true principles* of which, I trust, I can with verity affirm to be exclusively my own.

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